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ABSTRACT

This booklet, one of a series developed by the Frederick County Board of Education, Frederick, Maryland, provides an instruction module for an individualized or flexible approach to secondary science teaching. Subjects and activities in this series of booklets are designed to supplement a basic curriculum or to form a total curriculum, and relate to practical process oriented science instruction rather than theory or module building. Included in each booklet is a student section with an introduction, performance objectives, and science activities which can be performed individually or as a class, and a teacher section containing notes on the science activities, resource lists, and references. This booklet presents an investigation of the identification of an unknown chemical. The estimated time for completing the activities in this module is 2-3 weeks. (SL)

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ED130887

What is it?

AIDS TO INDIVIDUALIZE THE TEACHING OF SCIENCE

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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MINI-COURSE UNITS

BOARD OF EDUCATION OF FREDERICK COUNTY

1974

Marvin G. Spencer

SE 021 629

WHAT IS IT?

IDENTIFICATION OF AN UNKNOWN CHEMICAL SUBSTANCE

Prepared by

Jane Tritt

Estimated Time for Completion

2-3 weeks

Frederick County Board of Education

Mini Courses for

Physical Science, Biology, Science Survey,

Chemistry and Physics

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Frederick, Maryland

1974

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FOREWORD

The writing of these instructional units represents Phase II of our science curriculum mini-course development. In Phase 1, modules were written that involved the junior high disciplines, life, earth and physical science. Phase II involves senior high physical science, biology, chemistry, physics and science survey.

The rationale used in the selection of topics was to identify instructional areas somewhat difficult to teach and where limited resources exist. Efforts were made by the writers of the mini-courses to relate their subject to the practical, real world rather than deal primarily in theory and model building.

It is anticipated that a teacher could use these modules as a supplement to a basic curriculum that has already been outlined, or they could almost be used to make up a total curriculum for the entire year in a couple of disciplines. It is expected that the approach used by teachers will vary from school to school. Some may wish to use them to individualize instruction, while others may prefer to use an even-front approach.

Primarily, I hope these courses will help facilitate more process (hands on) oriented science instruction. Science teachers have at their disposal many "props" in the form of equipment and materials to help them make their instructional program real and interesting. You would be remiss not to take advantage of these aids.

It probably should be noted that one of our courses formerly called senior high physical science, has been changed to science survey. The intent being to broaden the content base and use a multi-discipline approach that involves the life, earth and physical sciences. It is recommended that relevant topics be identified within this broad domain that will result in a meaningful, high interest course for the non-academic student.

ALFRED THACKSTON, JR.
Assistant Superintendent for Instruction

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WHAT IS IT?

IDENTIFICATION OF AN UNKNOWN CHEMICAL SUBSTANCE

While studying chemistry as part of the physical science course, you have learned how to measure and weigh materials, and handle laboratory equipment. You are now ready to perform some practical uses of what you have learned.

During this minicourse, you will be identifying different compounds. Your instructor will give you a substance, and your job will be to test the substance and find out what it is. This is called qualitative analysis.

There are many ways scientists use qualitative analysis. They are constantly testing the air to determine its composition to see if there are any elements in it causing pollution.

Testing for poisonous elements in water is also the concern of the qualitative chemist.

Qualitative analysis was used to test the composition of the moon rocks. It is used to test our food to determine if any poisonous substances may be absorbed through plants, and in testing food additives.

Scientists also use qualitative analysis in testing for causes of death in suicide and murder victims!

A. Adjusting Bunsen Burner

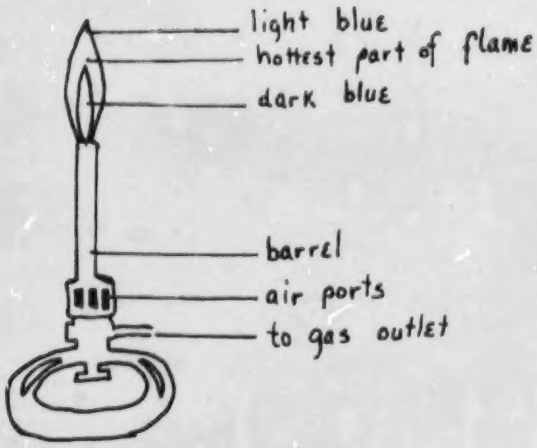
OBJECTIVE

The student will be able to:

1. properly adjust a bunsen burner for qualitative analysis

ACTIVITY

a. Refer to Worksheet #1 and follow instructions



Hook burner to gas source. Light match, then turn on gas. Hold match 1 cm above barrel to ignite. Adjust flame by turning the section of burner where air ports are near base of burner.

Adjust flame as demonstrated by your teacher, so that it is a <u>blue</u> non-luminous (not yellow) flame. You should be able to see a dark blue cone within a light blue cone. Above the dark blue cone is the hottest part of the flame. Here is where you perform <u>flame tests</u>.

B. Filtration

OBJECTIVES

The student will be able to:

2. fold and properly use filter paper.

3. distinguish between a filtrate and a residue.

4. identify a precipitate.

ACTIVITY

a. Refer to Worksheet #2 and follow instructions there.

Worksheet #2

During the lab experiments in qualitative analysis, you will be filtering substances.

Follow the procedure for filtering. Be sure to learn the meanings of the underlined words.

Take piece of filter paper, fold in half, then in half again. See figure below. Separate the folds of filter paper, with three thicknesses on one side and one on the other, then place in the funnel. Funnel should be wet before paper is added. Then wet the filter paper with a little water and press edges firmly against the funnel.

Place 10 ml sodium chloride solution in a small beaker. Place 10 ml silver nitrate solution in another beaker. Pour the 2 solutions together.

The white insoluble substance that formed in the beaker is called a <u>precipitate</u>.

Set funnel with filter paper in ring attached to ring stand. Place beaker underneath. Pour material containing precipitate in funnel being careful not to overflow the filter paper. The clear liquid passing through the filter paper into the beaker is called the <u>filtrate</u>. The solid substance remaining in the filter paper is called the <u>residue</u>.

Answer the following questions.

1. A precipitate is _____.

2. A filtrate is _____.

3. A residue is _____.

C. Wire holder

OBJECTIVE

The student will be able to:

5. make a wire holder and test wire.

ACTIVITY

a. Refer to Worksheet #3 and follow instructions.

When testing for some positive ions, you will be doing a flame test. For this you need to make a test wire and holder.

Cut a 10 cm piece of wire from a roll of nichrome wire with wire cutter.

Take a small piece of balsa wood and insert wire into wood pushing wire so that it goes into wood 2 cm. Hold wood as the handle.

Another way to make a test wire and holder is to insert wire into eraser of pencil and use the pencil as the handle.

Your teacher will tell you which test wire holder to make.

Use a new wire for each test, but reuse the wire holder.

You will learn how to perform the flame test in Worksheet #7.

D. Blowpipe Use

OBJECTIVE

The student will be able to:

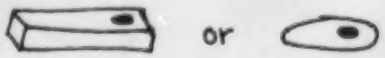
6. use blowpipe properly.

7. use charcoal block with blowpipe.

ACTIVITY

a. Refer to Worksheet #4 and follow instructions.

Get a charcoal block or charcoal briquette from your teacher. With spatula, dig a small hole near one end of the block or briquette.

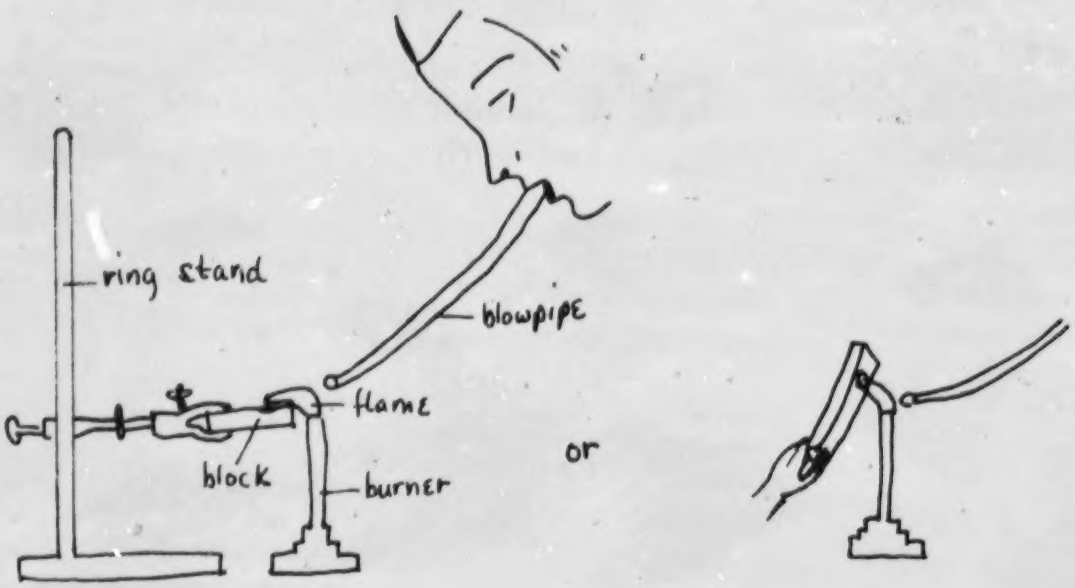


Get brass blowpipe from your teacher.

The large end of the blowpipe is the end you will blow into. To sterilize the blowpipe, hold the large end in the bunsen flame for about 30 seconds. Cool under running water. Do not dip into a beaker of water! (You never know what was in the beaker.)

Set up ringstand and clamp, and attach charcoal as in the figure below. Light burner, and blow through sterilized blowpipe directing the flame toward the charcoal block.

An alternate method is to hold the block with your hand and blow through flame onto charcoal block. (Briquettes are too small to hold in your hand.)



Now that you learned some uses of the materials needed for qualitative analysis, you are ready to begin practicing to see if you can identify elements by testing.

You will be testing salts in the laboratory, and the purpose of testing is to try and identify the ion (element or radical) in the salt.

A salt is a substance made of 2 parts. The first part contains an ion (a charged atom) that is positive. These are mostly metals. The second part of a salt contains the negative ion.

An example of a salt is copper sulfate.

The copper is first, so is the positive ion. The sulfate is last and is the negative ion.

During the practice session, you will be given salts which contain ions to be tested. You will be testing the positive ions first - then the negative ions. You will be told the names of the ions and then by following the instructions on the worksheets, you can see the results of the test for that ion.

After you have finished practicing to see the results of the ion tests, you will have a test which will consist of one, two or three salts or unknowns you are to identify.

Before you start practicing, read the following for good laboratory technique.

1. Wear lab apron and goggles at all times.

2. Use only a small amount of salt for testing.

3. Use clean glassware.

4. Do not contaminate contents of reagent bottles and solution bottles. Never put eyedropper into these bottles. Pour a small amount of solution in a small test tube and use from there.

5. Never pour used solutions from test tubes back into bottles.

6. NEVER taste any salt - most salts are POISONOUS!

E. Positive Ions - Group I

OBJECTIVES

The student will be able to:

8. identify the lead ion by testing.

9. identify the silver ion by testing.

ACTIVITY

a. Refer to Worksheet #5 and follow instructions.

Worksheet #5

TESTING POSITIVE IONS - GROUP I

Group I - lead and silver

Place a small amount of unknown (size of a pea) in a 50 ml or 100 ml beaker. Add 10 ml water and stir until dissolved. With eye dropper, add hydrochloric acid a few drops at a time. If either lead or silver are present, a white precipitate forms. Keep adding the acid until no more precipitate forms.

*NOTE: If no precipitate forms when the hydrochloric acid is added, you do not have an ion in this group. Proceed to Group II.

If a precipitate does form, continue the following procedure.

lead: filter to separate precipitate from remaining solution. Throw filtrate away and replace beaker under funnel. Pour 30 ml boiling water over residue and collect filtrate in beaker. Add 5 drops potassium chromate solution to filtrate. A bright yellow precipitate forming means you have lead.

silver: Pour 10 ml ammonium hydroxide solution over residue in filter paper. If the residue dissolves, you have silver.

F. Positive Ions - Group II

OBJECTIVES

The student will be able to:

10. identify the zinc ion by testing.

11. identify the aluminum ion by testing.

ACTIVITY

a. Refer to Worksheet #6 and follow instructions.

Worksheet #6

TESTING POSITIVE IONS - GROUP II

Group II - zinc and aluminum

The test for these ions is called the cobalt nitrate test.

With a spatula, dig a small hole in a charcoal block or briquette. Place a small amount of solid unknown in the depression. Place one drop of water on the solid to keep it in place. With blowpipe, direct bunsen flame on the depression that contains the unknown. Heat one minute. Add 3 drops of cobalt nitrate solution on the unknown. Heat again for one minute by the blowpipe flame.

Cool. Look at block where unknown is. If there is a green color on the block, you have zinc ions. If a blue color is on the block, you have aluminium ions.

*NOTE: If no color shows up on the block, you do not have either zinc or aluminum. Proceed to Group III

G. Positive Ions - Group III

OBJECTIVES

The student will be able to:

12. identify the lithium ion by testing.

13. identify the copper ion by testing.

14. identify the sodium ion by testing.

15. identify the potassium ion by testing.

ACTIVITY

a. Refer to Worksheet #7 and follow instructions.

Worksheet #7

TESTING POSITIVE IONS - GROUP III

Group III - lithium, copper, sodium, potassium

The test for these ions is called the flame test.

Take wire holder with wire (the one you made for Worksheet #3).

Adjust bunsen burner properly. Place end of wire in the hottest part of the bunsen flame. (Be sure the flame does not glow a color.) While the wire is hot, dip end into unknown solid substance. Place wire back in flame of burner. The flame will glow the following colors if you have an ion in this group.

lithium - magenta (red)
copper - green with white streak up the center
sodium - bright yellow-orange
potassium - lavender - pink

*NOTE: If no color shows up in the flame test, you do not have any ions in this group; proceed to Group IV.

H. Positive Ions - Group IV

OBJECTIVES

The student will be able to:

16. identify the iron ion by testing.

17. identify the cobalt ion by testing.

18. identify the nickel ion by testing.

ACTIVITY

a. Refer to Worksheet #8 and follow instructions.

Worksheet #9

TESTING POSITIVE IONS - GROUP IV

Group IV - iron, cobalt, nickel

Place some unknown the size of a pea in a test tube. Add water to ¼ full. Shake to dissolve unknown. Add 5 drops ammonium hydroxide solution to unknown solution. If you have ions in this group, the following colored precipitates will result.

iron - dark brown precipitate
cobalt - dark blue precipitate which dissolves if extra ammonium hydroxide is added
nickel - light green to blue precipitate

I. Negative Ions - Group I

OBJECTIVES

The student will be able to:

19. identify the sulfate ion by testing.

ACTIVITY

a. Refer to Worksheet #9 and follow instructions.

Worksheet #9

TESTING NEGATIVE IONS - GROUP I

Group I - sulfate

Place a small amount of unknown (the size of a pea) in a test tube. Fill to ½ full with water. Shake until the unknown dissolves. Add 10 drops barium chloride solution to the test tube.

A white precipitate forming may mean a sulfate is present. Add 10 drops of hydrochloric acid to the test tube with the precipitate. If the precipitate does not dissolve, a sulfate is present.

*NOTE: If you do not get a precipitate when barium chloride is added, you do not have ions in Group I or Group II. Proceed to Group III.

J. Negative Ions - Group II

OBJECTIVES

The student will be able to:

20. identify the presence of a carbonate ion by testing.

21. identify the presence of a phosphate ion by testing.

ACTIVITY

a. Refer to Worksheet #10 and follow instructions.

Worksheet #10

TESTING NEGATIVE IONS - GROUP II

Group II - carbonate, phosphate

Place a small amount of unknown (the size of a pea) in a test tube. Fill to ½ full with water. Shake until the unknown dissolves. Add 10 drops barium chloride solution to the test tube. A white precipitate forms as in Group I negative ions. Continue the following tests to determine which ion you may have in this group.

carbonate: Add 10 drops hydrochloric acid to the precipitate in the test tube. If the liquid effervesces (fizzes) and the precipitate dissolves, you have a carbonate.

phosphate: Place a small amount of unknown (size of pea) in a test tube. Fill to ½ full with water. Fill to ½ full with dilute nitric acid. Add 10 drops ammonium molybdate solution and heat gently over bunsen flame. A yellow precipitate forms if a phosphate is present.

K. Negative Ions - Group III

OBJECTIVES

The student will be able to:

22. identify the presence of chloride ions by testing.

23. identify the presence of bromide ions by testing.

24. identify the presence of iodide ions by testing.

ACTIVITY

a. Refer to Worksheet #11 and follow instructions.

Worksheet #11

TESTING NEGATIVE IONS - GROUP III

Group III - chloride, iodide, bromide

Place a small amount of unknown the size of a pea in a test tube. Fill to ½ full with water and shake until it dissolves. Add 10 drops silver nitrate solution. A white precipitate tells you you have an ion in this group.

*NOTE: If a white precipitate does not form you do not have ions in this group. Proceed to Group IV. If you do have a precipitate, continue the following instructions.

chloride: Add to the test tube with the unknown and precipitate ammonium hydroxide to ½ full. If the precipitate dissolves, you have a chloride.

bromide or iodide: In clean test tube place a small amount of unknown the size of a pea. Fill to ½ full with water. Shake until unknown dissolves. Add to this unknown solution carbon tetrachloride. Fill to ½ full. Add chlorox to this. Fill test tube to 3/4 full. Shake all together and allow to settle. Observe the bottom layer in the test tube. If the bottom layer is yellow-orange, you have a bromide. If it is violet, you have an iodide.

L. Negative Ions - Group IV

OBJECTIVES

The student will be able to:

25. identify the presence of an acetate ion by testing.

26. identify the presence of a nitrate ion by testing.

ACTIVITY

a. Refer to Worksheet #12 and follow instructions.

TESTING NEGATIVE IONS - GROUP IV

Group IV - acetate, nitrate

acetate: Place an amount of unknown the size of a pea in a test tube. Add only 5 drops of water and shake to make a very strong solution. Add and fill to ½ full with ferric chloride solution. A reddish brown precipitate forming indicates you have an acetate.

nitrate: If no precipitate forms by performing the above test, you have a nitrate.

M. Identification of an Unknown Salt

OBJECTIVE

The student will be able to:

27. identify the composition of an unknown salt.

ACTIVITY

a. Refer to Worksheet #13 and follow instructions there.

Receive unknown salt from instructor. As you have learned, the salt contains two kinds of ions: one positive ion and one negative ion.

Start with a small amount of unknown and test through Groups I, II, III and IV.

After you have found the positive ion, go through and test Groups I, II, III and IV for the negative ion.

As an example, let's say a student tested for the positive ion and found out he had the element potassium. He then tested for the negative ion and found to have bromide ions.

Therefore, the name of the salt he found was POTASSIUM BROMIDE. This is the name of the substance he was given and the name of the unknown!

UNIT OBJECTIVES

The student will be able to:

1. properly adjust a bunsen burner for qualitative analysis.
2. fold and properly use filter paper.
3. distinguish between a filtrate and a residue.
4. identify a precipitate.
5. make a wire holder and test wire.
6. use a blowpipe properly.
7. use a charcoal block with blowpipe.
8. identify the lead ion by testing.
9. identify the silver ion by testing.
10. identify the zinc ion by testing.
11. identify the aluminium ion by testing.
12. identify the lithium ion by testing.
13. identify the copper ion by testing.
14. identify the sodium ion by testing.
15. identify the potassium ion by testing.
16. identify the iron ion by testing.
17. identify the cobalt ion by testing.
18. identify the nickel ion by testing.
19. identify the sulfate ion by testing.
20. identify the carbonate ion by testing.
21. identify the phosphate ion by testing.
22. identify the chloride ion by testing.

23. identify the bromide ion by testing.

24. identify the iodide ion by testing.

25. identify acetate ion by testing.

26. identify the nitrate by testing.

27. identify the composition of an unknown salt by testing.

This course is designed to allow students to make use of the laboratory every day.

They learn to be very observant by seeing colors and precipitates.

Students like qualitative analysis because it requires little reading and gives them a practical concept of chemistry.

Students that have reading problems have no trouble with this, as a matter of fact, usually do very well.

The best time to have students work on this minicourse is after they have completed some or all of the chemistry part of the physical science course.

Students should have the worksheets to look at. Try not to spoon-feed them too much. They should be able to follow the instructions and carry out the procedure themselves. This is one of the main purposes of this course: <u>following instructions</u> - and <u>observation</u>.

During practice sessions, tell students what the ions are you are handing them. Start with positive ions and only give them as many as they can test in a day. Later do the negative ions.

After the students have practiced, they will have a lab test. Each student will work by himself - but they can ask each other questions about colors and precipitates.

Give each student 3 unknowns. A list of soluble salts follows in this section. Place about 1 teaspoonful of salt in vial or small bottle. Number all bottles and allow student to pick any three of his choosing. Tell students they will receive no more unknown and not to ask for more. If you don't, you'll be filling bottles all day. Be sure to write the name of the salt beside each bottle number and keep in a safe place.

With 3 unknowns, there will be <u>6</u> answers: 3 positive and 3 negative ions.

Students should write their name, the salt numbers, and name of salts they find on an answer sheet. When all three unknowns are completed (about 3 days), collect answer sheets. It is best to wait until students complete <u>all</u> 3 unknowns before giving them answers.

During the test there may be sharing of opinions of colors, etc., among students.

If they are uncertain about a precipitate or color, allow them to ask each other. The final answer should be the decision of the student having the unknown.

Tell them "You can ask each other but don't ask me", and refuse to answer any questions. If you help <u>one</u> student, you'll have to help them all.

Possible test scores and grades:

6 ions correct	-	100	=	A
5 ions correct	-	90	=	A
4 ions correct	-	85	=	B
3 ions correct	-	75	=	C
2 ions correct	-	70	=	C
1 ion correct	-	60	=	D
0 ions correct	-	50	=	F

You can use any grading system you want - you'll be surprised to see a lot of A's and B's.

Need for Each Lab Station (Group of 4)

Reagents:
small, labeled bottles

- dilute hydrochloric acid - HC_1 (½ acid to ½ water)
- dilute ammonium hydroxide - NH_4OH (½ NH_4OH to ½ water)
- dilute nitric acid - HNO_3 (1/3 acid to 2/3 water)

Solutions:
small, labeled bottles

- cobalt nitrate solution (1 gram solid to 100 ml H_2O)
- ammonium molybdate (1 gram solid to 100 ml H_2O)
- potassium chromate or potassium dichromate solution (1 gram solid to 100 ml H_2O)
- ferric chloride solution (1 gram solid to 100 ml H_2O)
- barium chloride solution (1 gram solid to 100 ml H_2O)

Liquids:

- carbon tetrachloride
- chlorox (smell it to make sure it is not stale - it should have a strong chlorine odor)

Materials:

- 4 lab aprons
- 4 pair goggles
- 2 bunsen burners or alcohol burners
- 4 wire holders (6" lengths balsa wood)
- 20 test wires (#28 or 26 nichrome wire cut to 2" lengths)
- 2 blowpipes (borrow from chemistry department)
- 2 charcoal blocks (or charcoal briquettes)
- 2 funnels
- filter paper
- small beakers (50 ml or 100 ml) 2 graduated cylinders
- test tubes - Purex
- test tube rack
- 4 eye droppers

So that the unknown salt is soluble in water, use any of the following salts as unknowns.

sodium sulfate
sodium carbonate
sodium phosphate
sodium chloride
sodium iodide
sodium bromide
sodium nitrate
sodium acetate
lead nitrate
lead acetate
silver nitrate
silver acetate
zinc sulfate
zinc chloride
zinc bromide
zinc iodide
zinc nitrate
zinc acetate
aluminum sulfate
aluminum chloride
aluminum bromide
aluminum iodide
aluminum nitrate
aluminum acetate
potassium sulfate
potassium carbonate
potassium phosphate
potassium chloride
potassium bromide
potassium iodide
potassium nitrate
potassium acetate
lithium sulfate
lithium chloride
lithium bromide
lithium iodide
lithium nitrate
lithium acetate
copper sulfate
copper chloride
copper iodide
copper bromide
copper acetate
copper nitrate
iron sulfate
iron chloride
iron iodide
iron bromide
iron acetate
iron nitrate
cobalt sulfate
cobalt chloride
cobalt iodide
cobalt bromide
cobalt nitrate
cobalt acetate
nickel sulfate
nickel chloride
nickel iodide
nickel bromide
nickel nitrate
nickel acetate

Evaluation Form for Teachers

Name of mini-course _____

Evaluation Questions	Yes	No	Comments
1. Did this unit accomplish its objectives with your students?			
2. Did you add any of your own activities? If so, please include with the return of this form.			
3. Did you add any films that other teachers would find useful? Please mention source.			
4. Were the student instructions clear?			
5. Was there enough information in the teacher's section?			
6. Do you plan to use this unit again?			

7. Which level of student used this unit? _____

8. How did you use this unit - class, small group, individual? _____

_____

PLEASE RETURN TO SCIENCE SUPERVISOR'S OFFICE AS SOON AS YOU COMPLETE THE COURSE.

SCIENCE MINI-COURSES

PHYSICAL SCIENCE	Prepared by
ELECTRICITY: Part 1 (Types of Generation of Electricity)	Marvin Blickenstaff
ELECTRICITY: Part 2 (The Control and Measurement of Electricity	Marvin Blickenstaff
ELECTRICITY: Part 3 (Applications for Electricity)	Marvin Blickenstaff
CAN YOU HEAR MY VIBES? (A Mini-course on Sound)	Charles Buffington
LENSES AND THEIR USES	Beverly Stonestreet
WHAT IS IT? Identification of an Unknown Chemical Substance	Jane Tritt
BIOLOGY	
A VERY COMPLEX MOLECULE: D.N.A. The Substance that Carries Heredity	Paul Cook
Controlling the CODE OF LIFE	Paul Cook
Paleo Biology – BONES: Clues to Mankind's Past	Janet Owens
A Field Study in HUMAN ECOLOGY	Janet Owens
Basic Principles of GENETICS	Sharon Sheffield
HUMAN GENETICS – Mendel's Laws Applied to You	Sharon Sheffield
SCIENCE SURVEY	
WEATHER Instruments	John Fradiska
TOPOGRAPHIC Maps	John Geist and John Fradiska
CHEMISTRY	
WATER	Ross Foltz
PHYSICS	
PHYSICAL OPTICS	Walt Brilhart